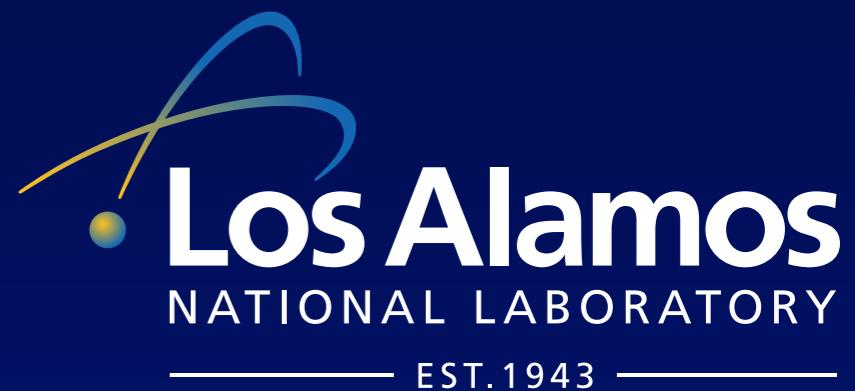


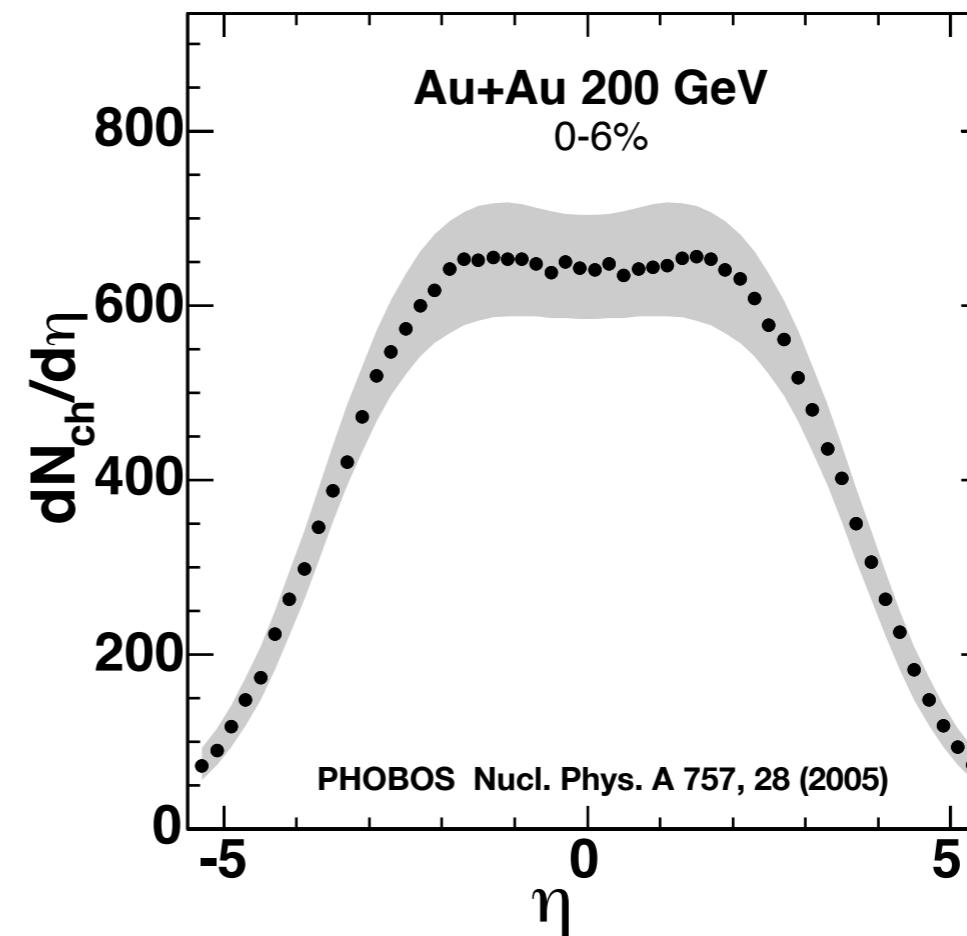
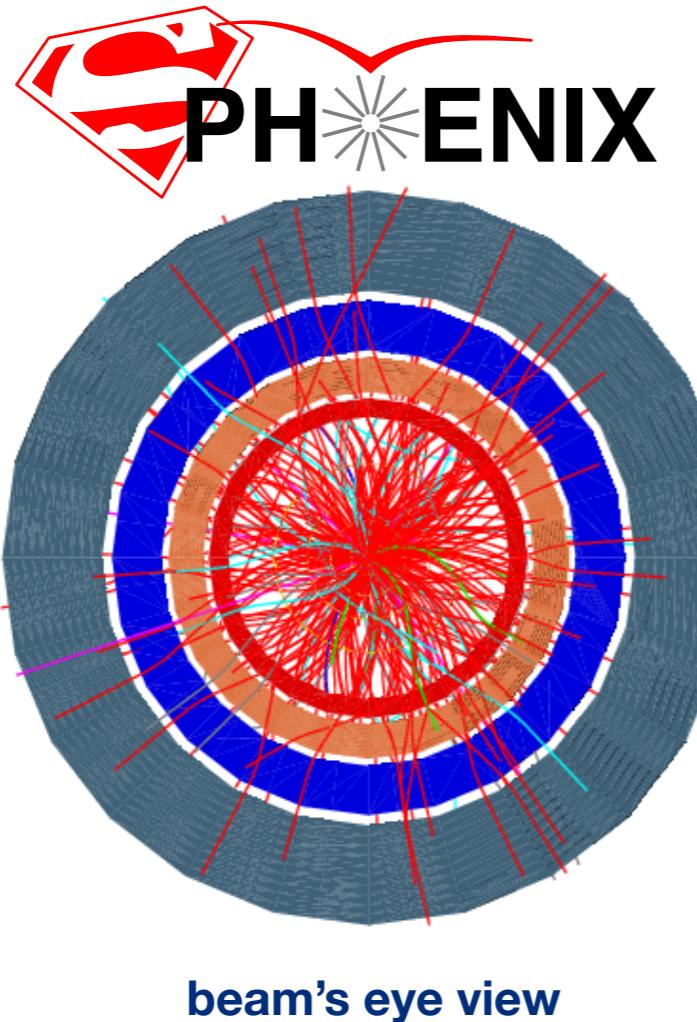
Jet Topics: Fake Backgrounds & Particle Flow

Michael P. McCumber
Los Alamos National Laboratory

sPHENIX Workshop
Stony Brook University, NY
July 27th 2015



Fake Jet Production



Large event multiplicities in heavy ion collisions
create jets from randomly associated soft particles, “fake jets”.

These jets appear preferentially at lower momentum
and at a sufficient rate to overwhelm the hard cross-section.

Our Approach(es)

Full GEANT4:

Complete modeling of material response and magnetic field

Pros:

Complete physics list and tuned to experimental data

Modeling of rare processes

Cons:

Computationally intensive

Typical Use:

Heavy ion samples < 100,000
Final design with more
Intractable > 1,000,000,000

Fast Simulation:

Parameterization of tracking resolutions and calorimeter showers with transverse profiles

Pros:

Resolutions and energy sharing informed by single particle GEANT4

Computationally efficient

Cons:

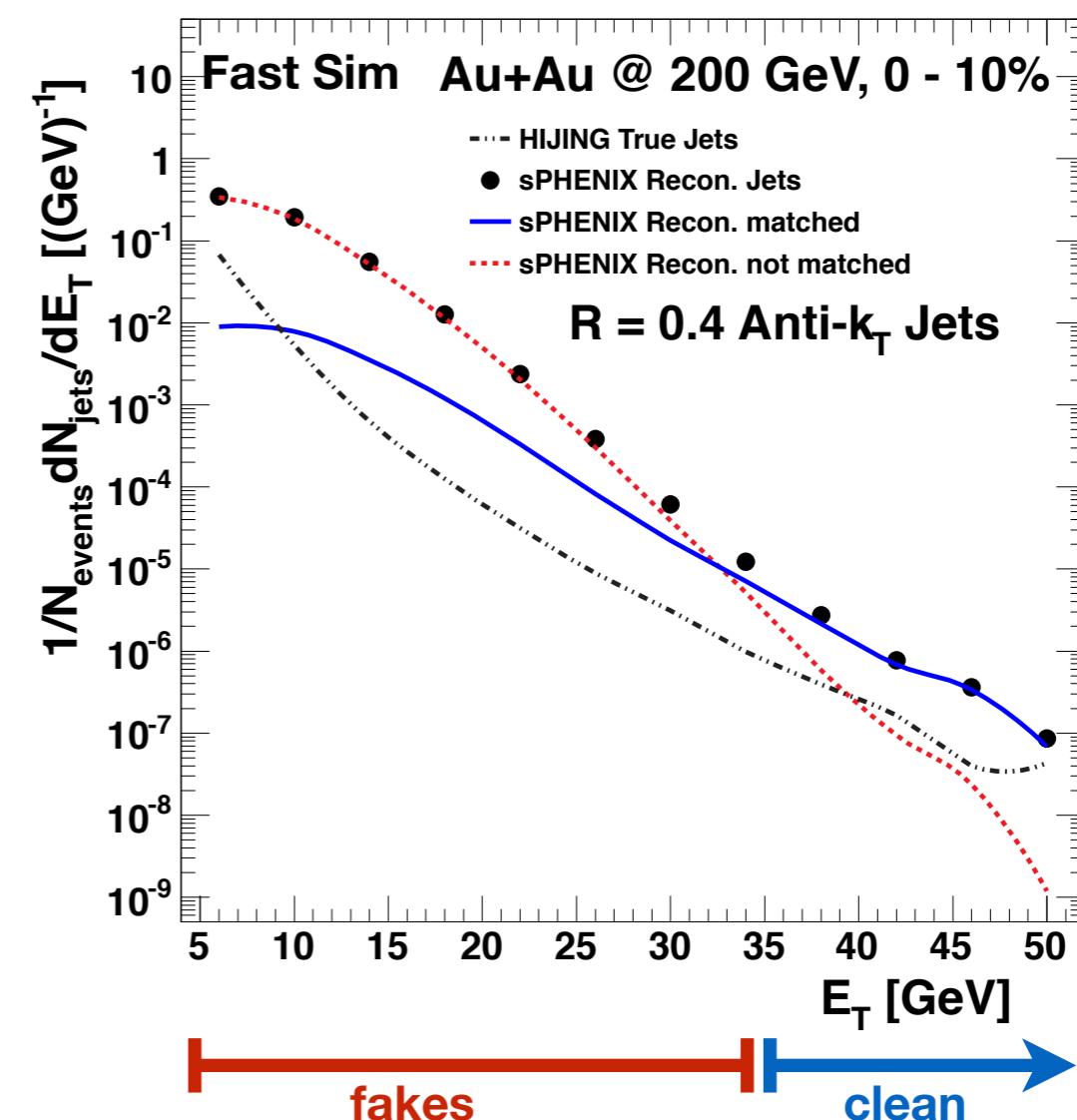
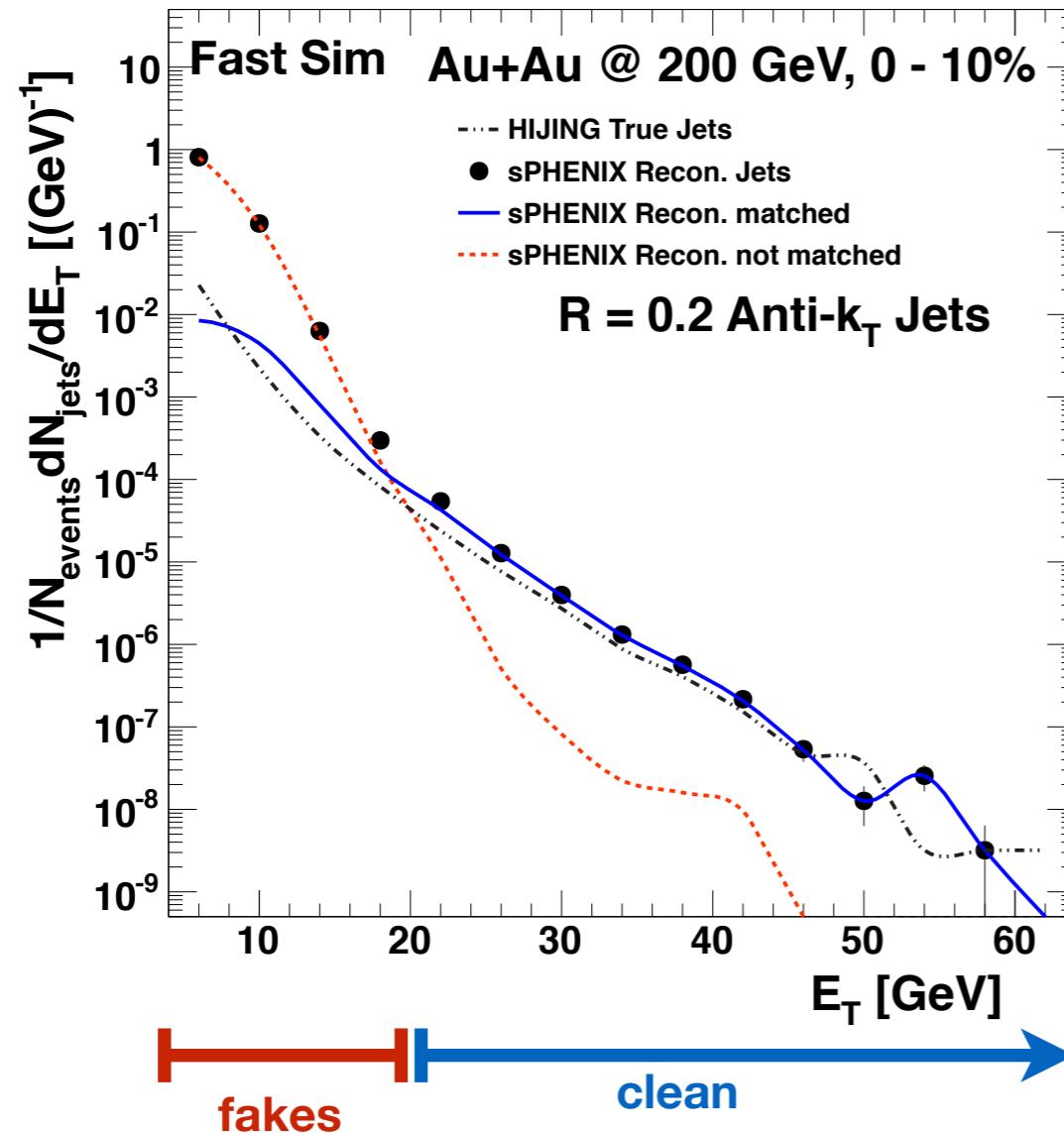
Fewer secondaries than GEANT4
Missing rare processes

Typical Use:

Heavy ion samples in 100,000,000s
Remains tractable > 1,000,000,000

Estimating Physics Reach

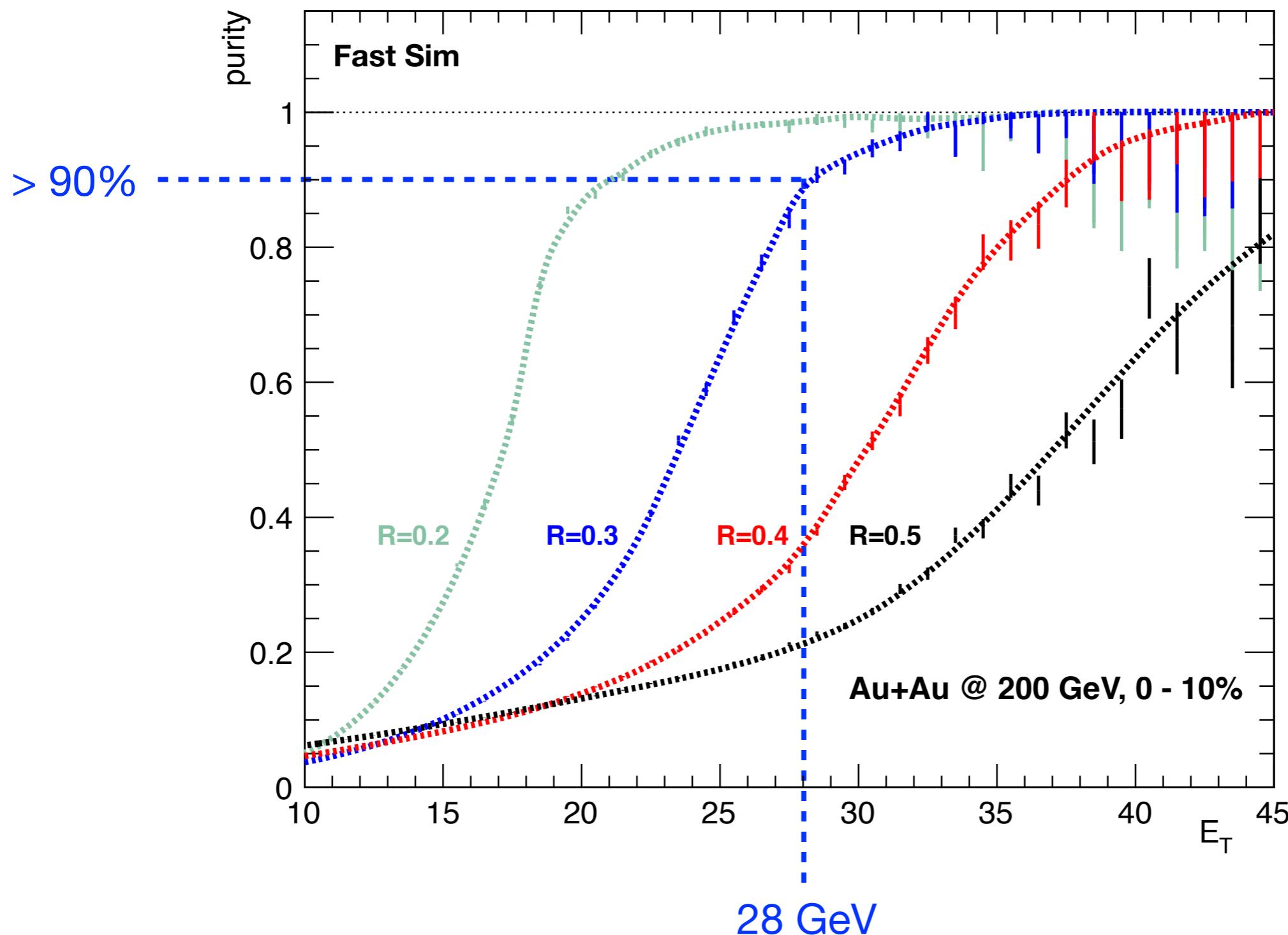
Deep inspection of HIJING ancestry identifies jets from hard scattering



Separation into true jets and fake jets allows the portion of the spectra influenced by fake jets to be determined.

Large radius jets capture more fluctuations and have a larger fake rate.

Real Jet Purities



90% is a very conservative requirement, useful for comparisons

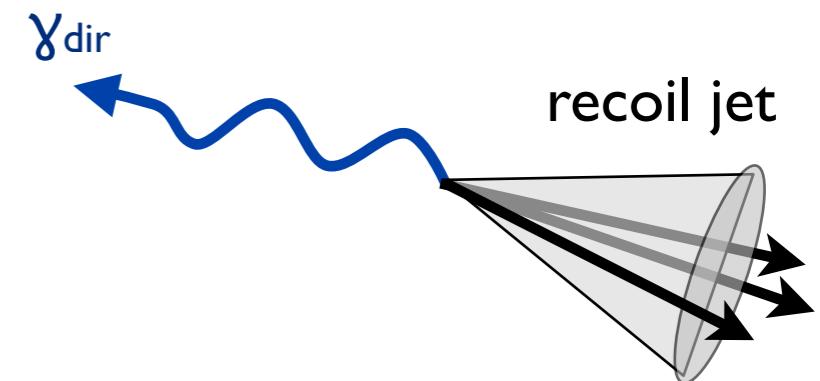
Fast simulation results shown here.

Full GEANT4 simulation

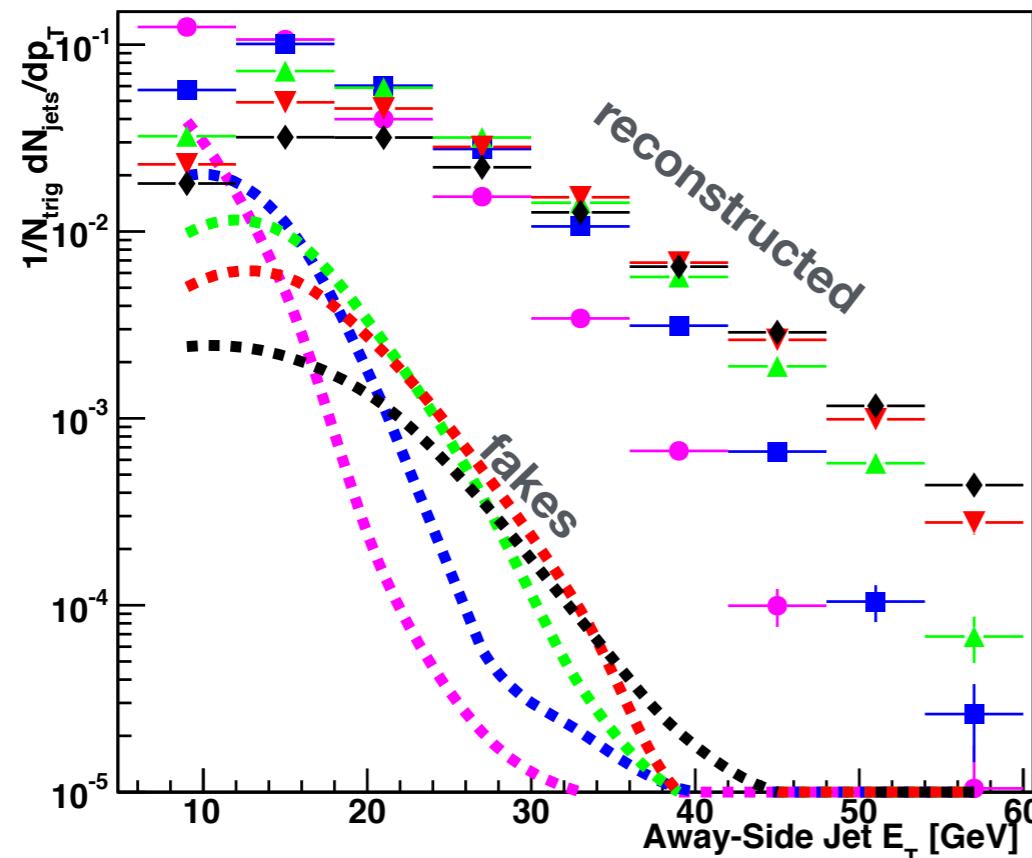
There are no “fake” high- p_T photons

Smaller event sample size for fakes

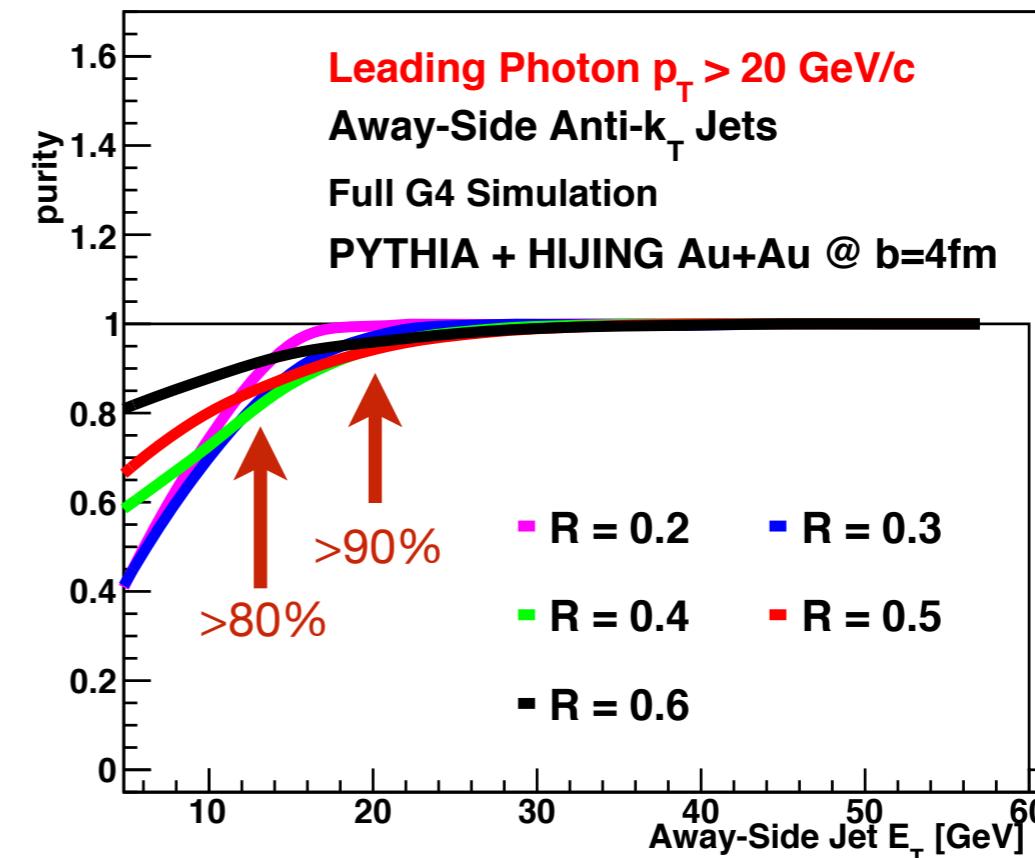
Embedded without quenching



Conditional spectra



Purities



GEANT4 measured purities for away-side jets:

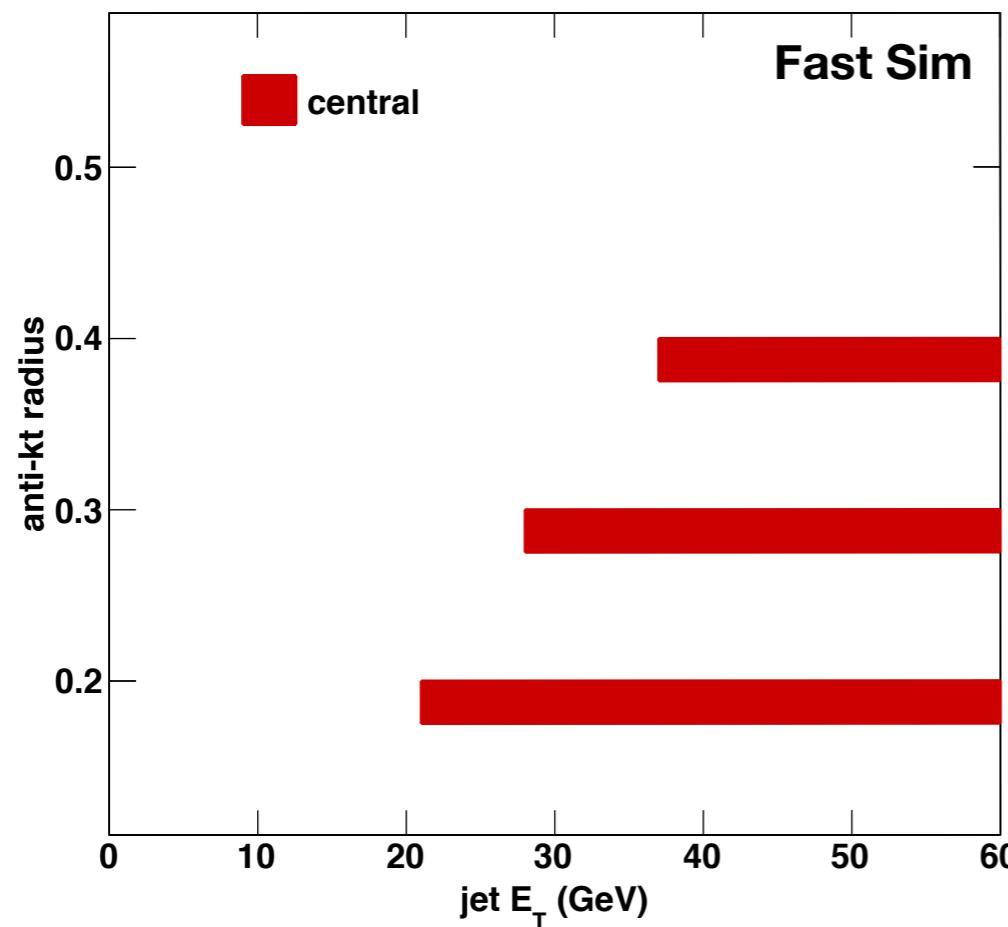
$E_T > 20 \text{ GeV}$ above 90% for radii 0.2-0.6

$E_T > 13 \text{ GeV}$ above 80% for radii 0.2-0.6

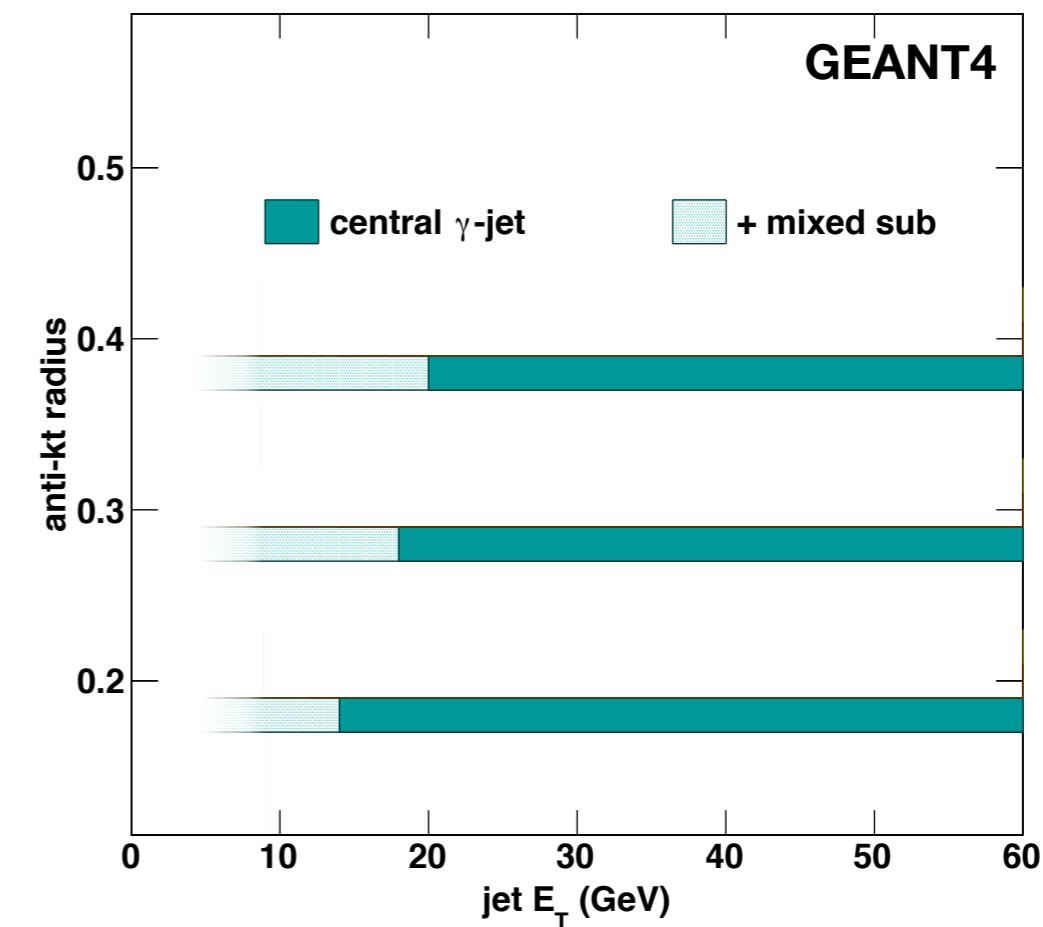
Fake Rate Limits

>90% Purity Limit Summary

Single Jets



Conditional Away-side Jets

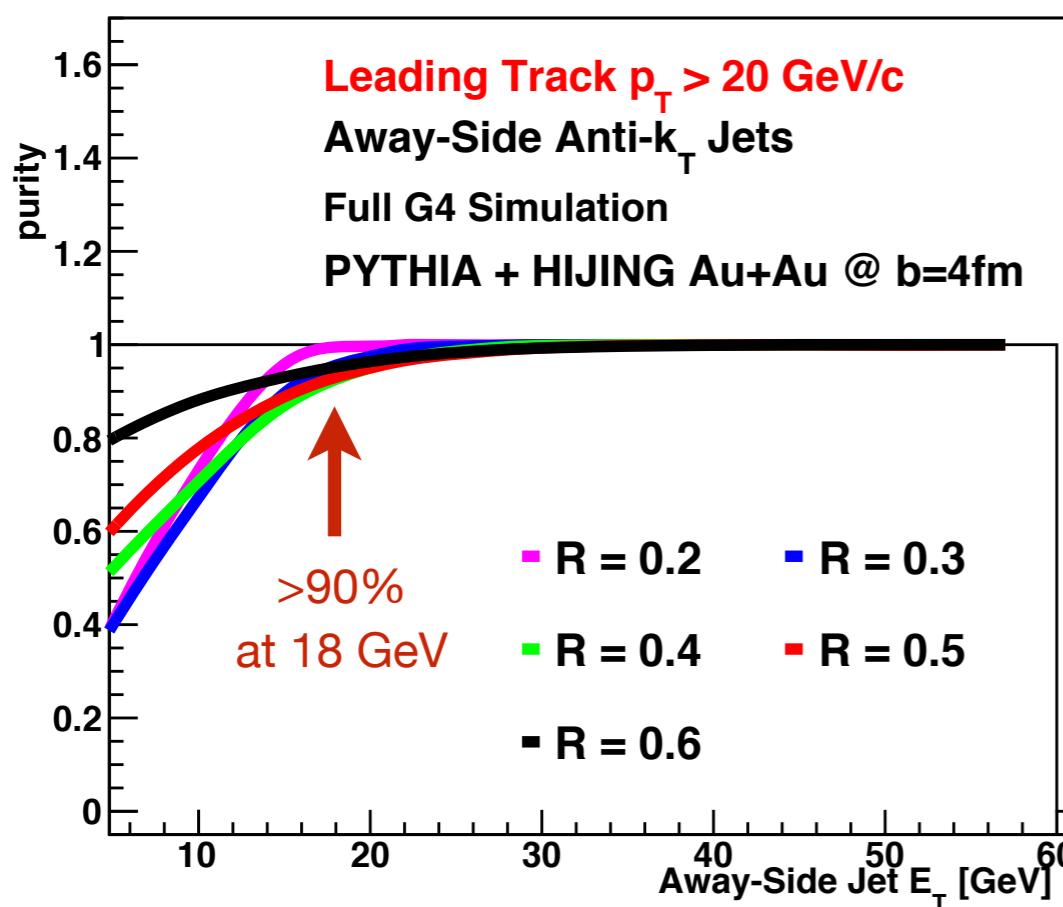
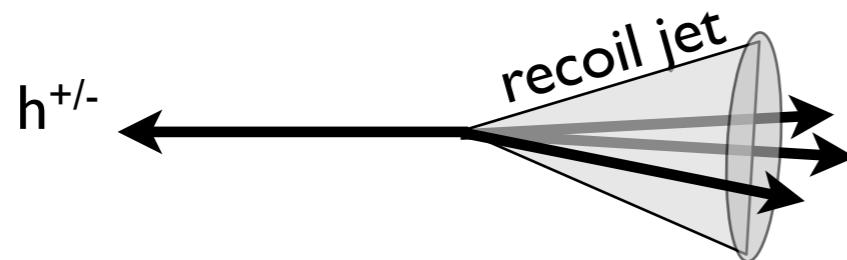


Comparative summary: Conservative 90% limits, mixed subtraction

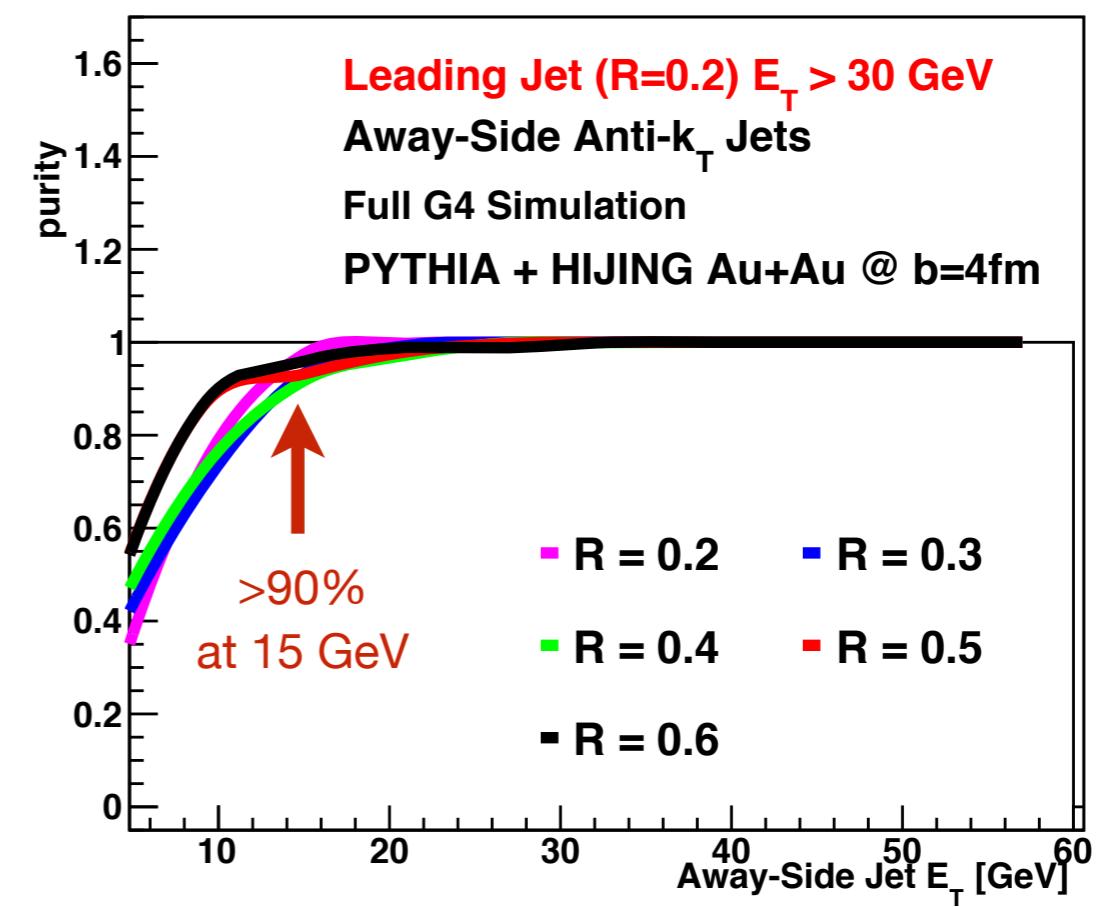
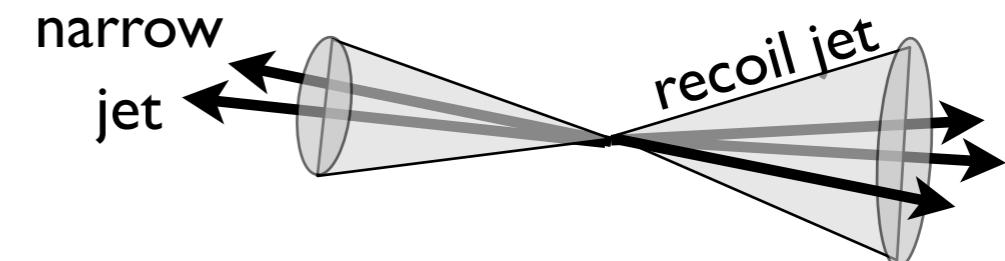
Away-side Correlations

Leading photons are not the only conditional we can use.

Charged Track Requirement



Narrow Jet Requirement



Large statistical samples of high momentum photons, tracks, and jets will make these invaluable tools for sPHENIX studies

Direct Rejection of Fake Jets

Methods:

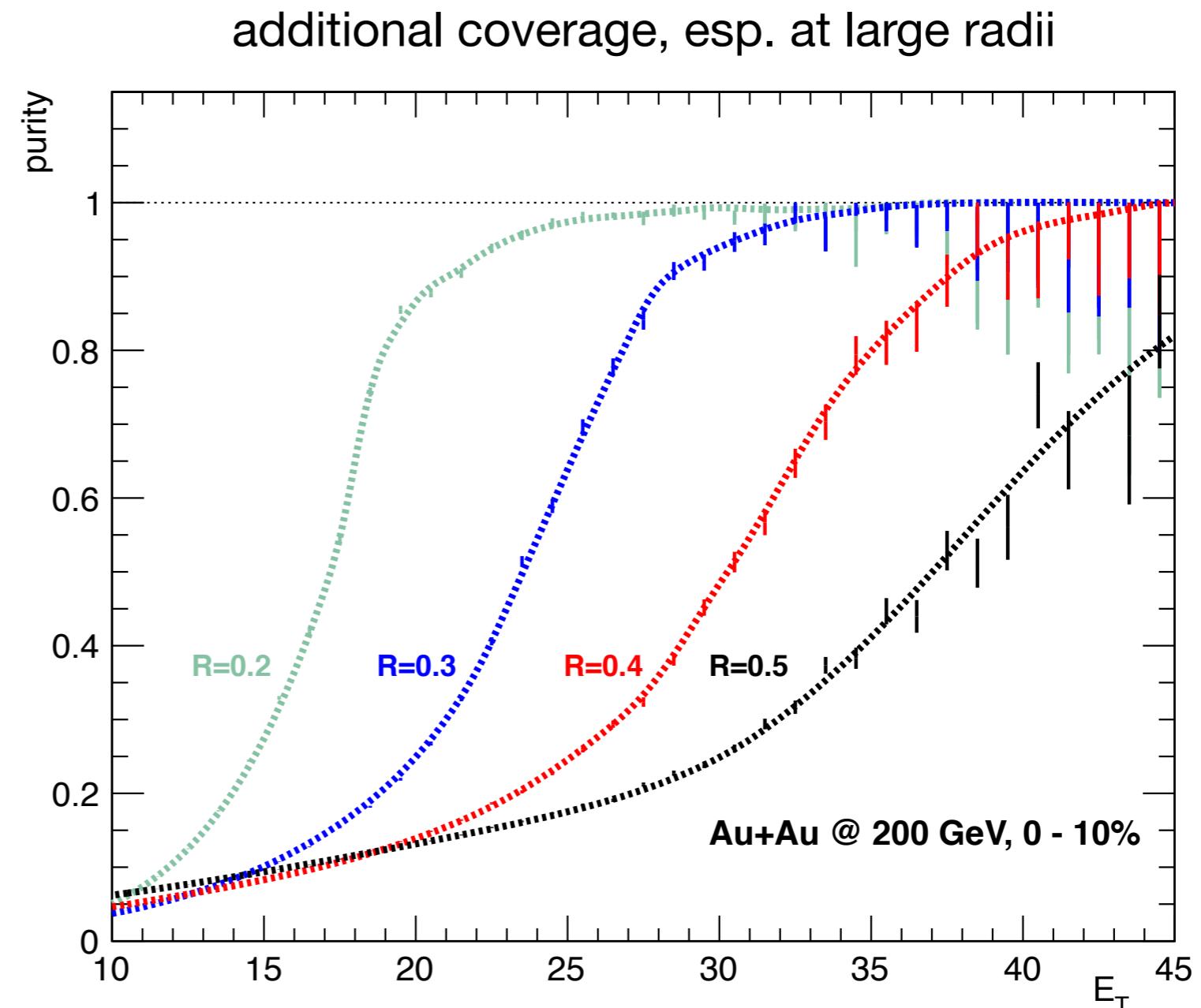
- minimum particle p_T
- Track Jet+EMCAL Match**
- jet shape selection
- away-side jet requirement

Matching Details:

Tracks >3 GeV in >7 GeV Jet

Or an EMCAL cluster >3 GeV

Angular coincidence within R



Dealing with Rejection Bias on Modified Jets:

large samples of minbias events will allow study rejection bias in data
added utility: engineer degree of surface bias

Direct Rejection of Fake Jets

Methods:

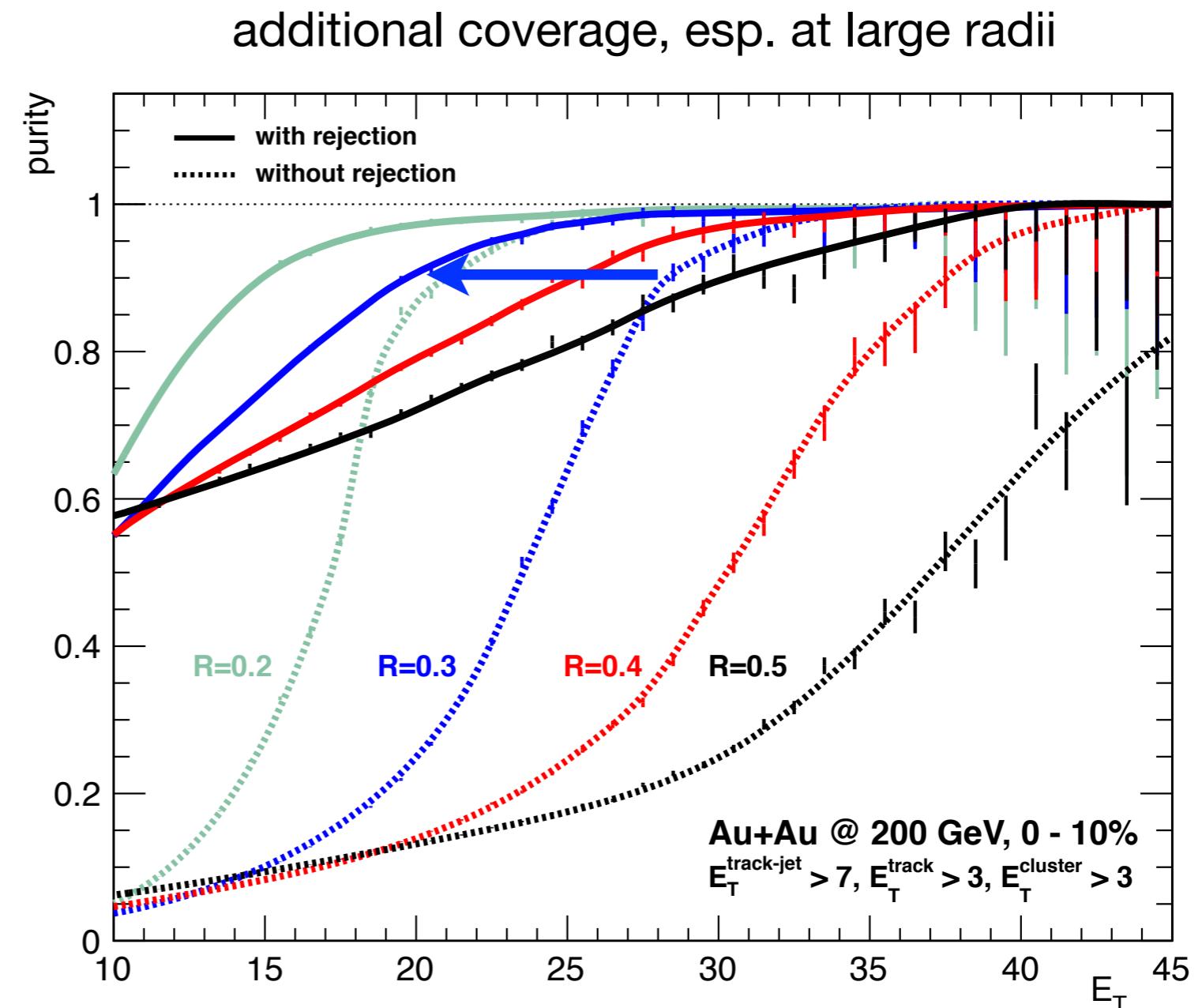
- minimum particle p_T
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- jet shape selection
- away-side jet requirement

Matching Details:

Tracks >3 GeV in >7 GeV Jet

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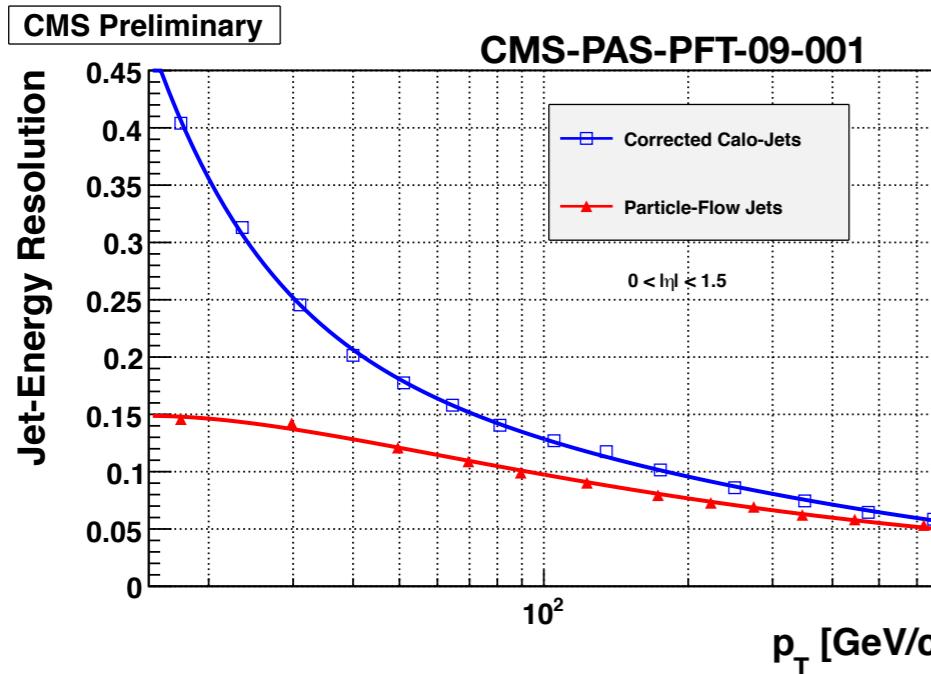
Angular coincidence within R



Dealing with Rejection Bias on Modified Jets:

large samples of minbias events will allow study rejection bias in data
 added utility: engineer degree of surface bias

Particle Flow Jets



Method Details:

iterate over all tracks

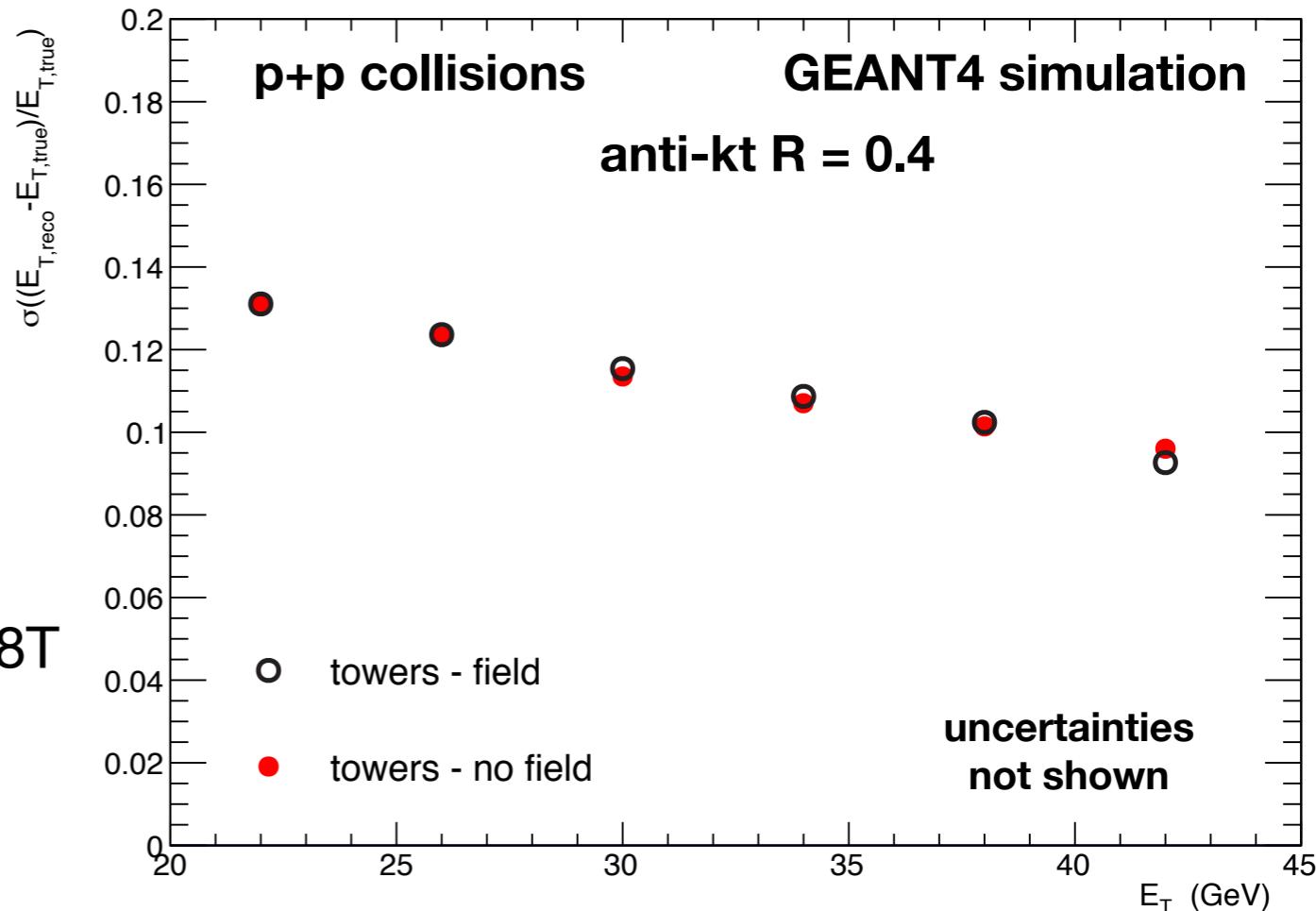
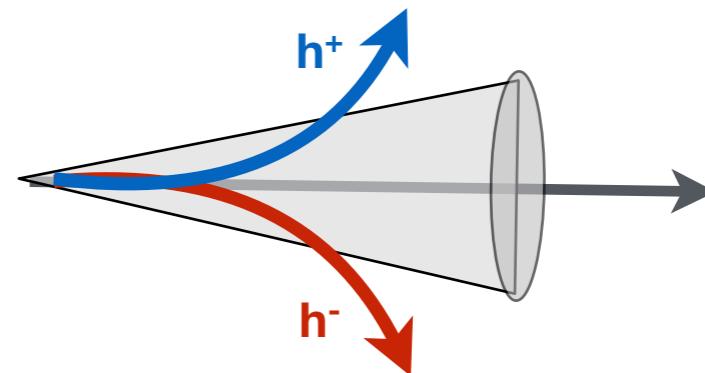
$E_{\text{trk}} \approx E_{\text{clus}}$: swap track for cluster

$E_{\text{trk}} < E_{\text{clus}}$: swap, but keep difference

run jet reconstruction

Improved Energy Resolution via:

- improve upon the calorimeter resolution
- remove magnetic field deflections



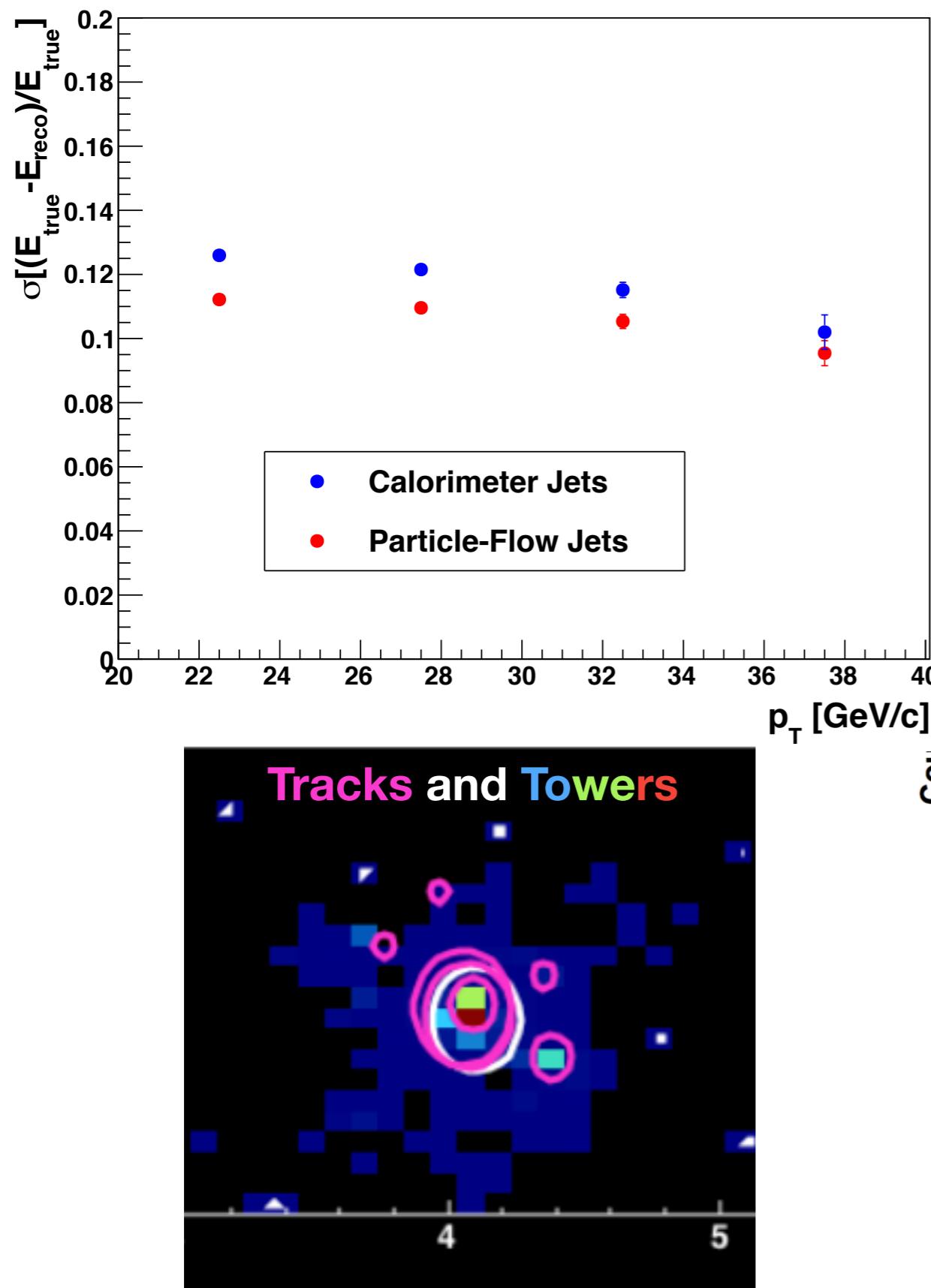
Result:

Little impact from deflection at 1.5T vs 3.8T

Little improvement on large cone jets

Resolution already quite good!

Particle Flow Jets Update



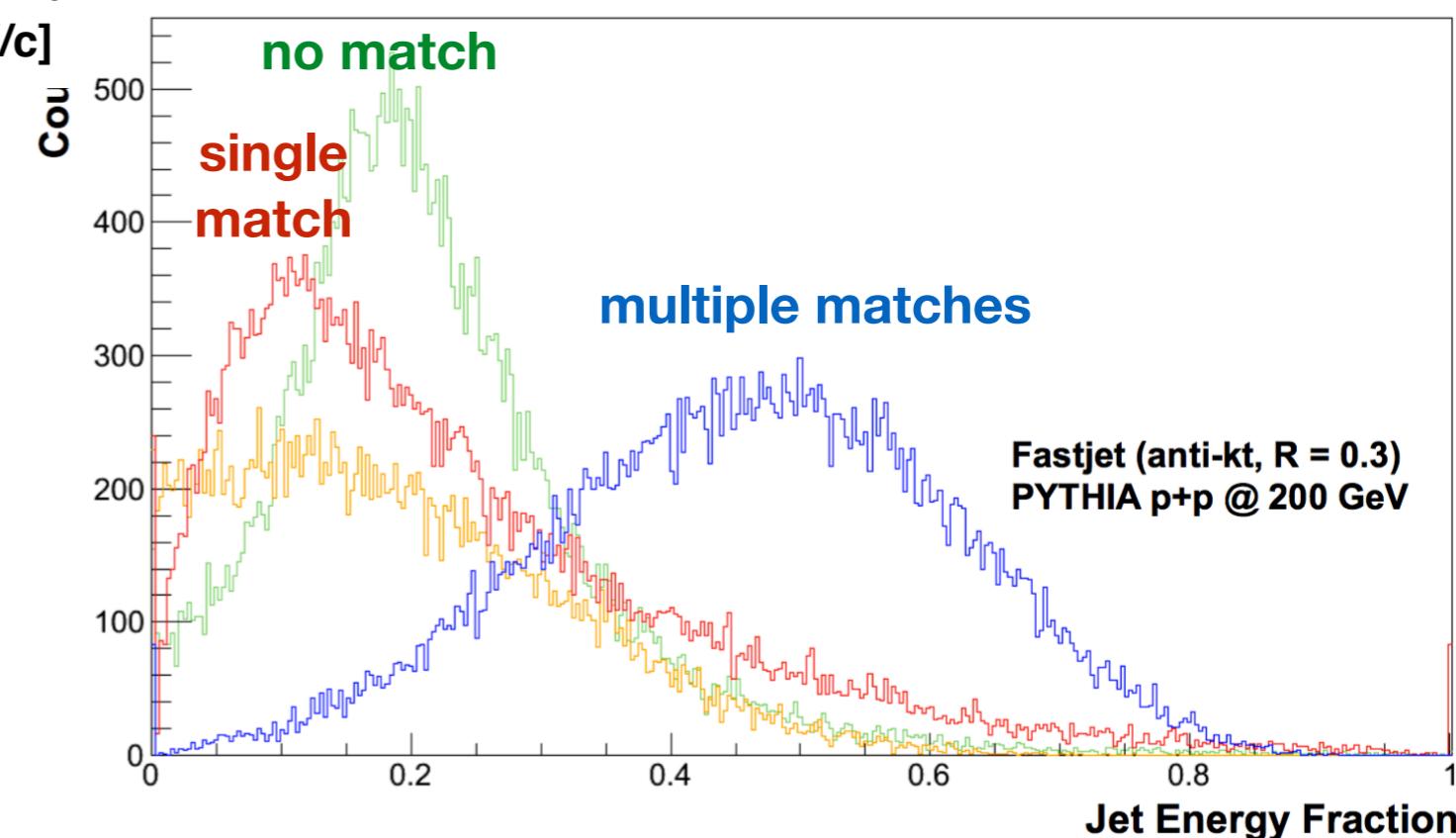
Since our proposal:

Ongoing effort to optimize flow jets

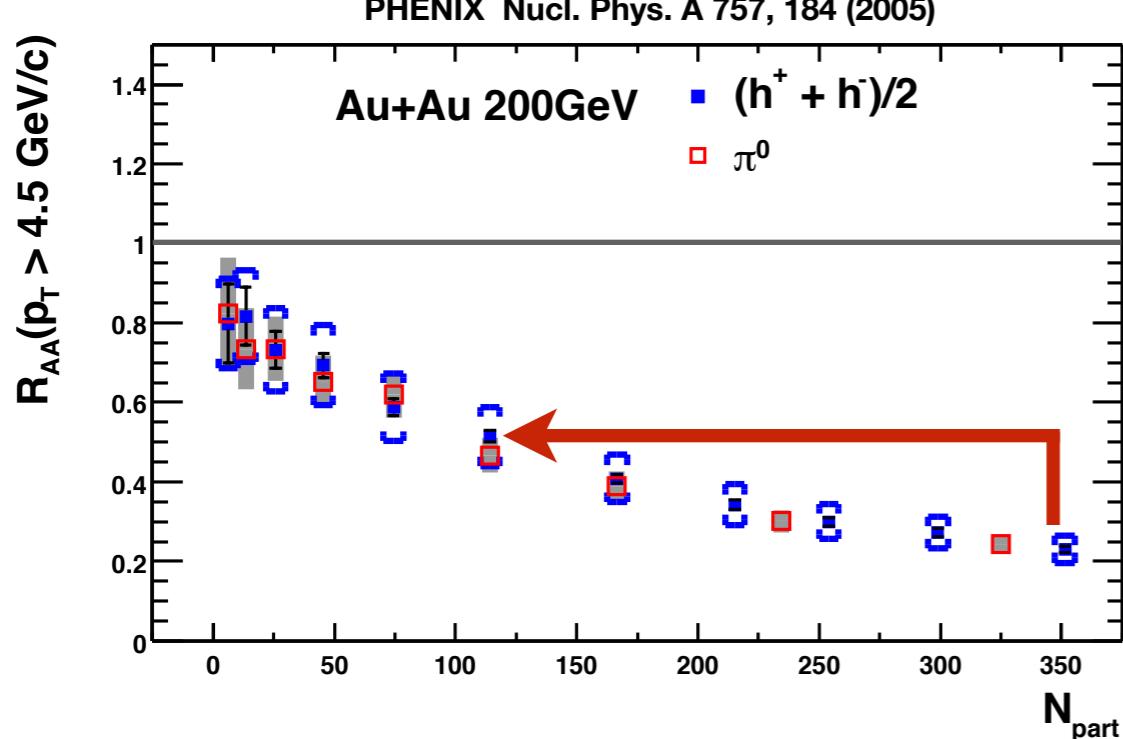
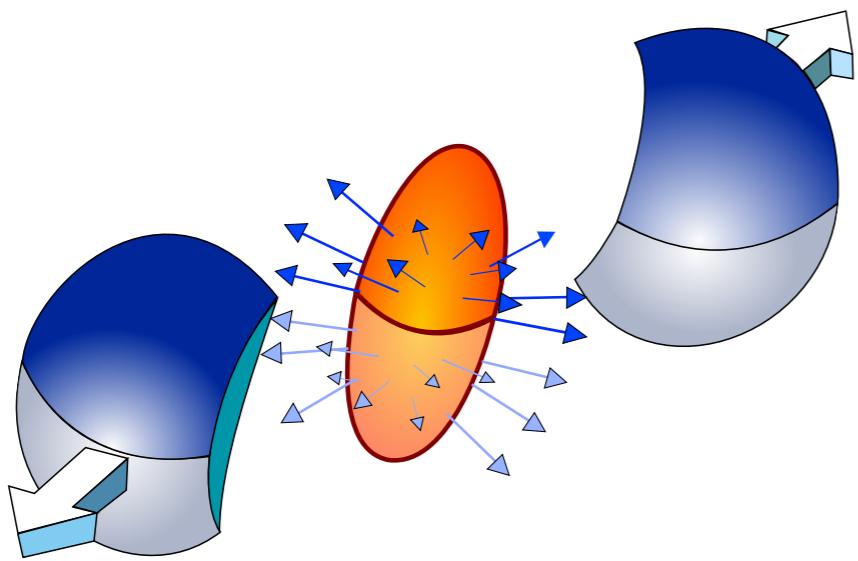
Currently have a 10% resolution improvement

Current calculation limited by **multiple matches**

Focus on clustering refinements

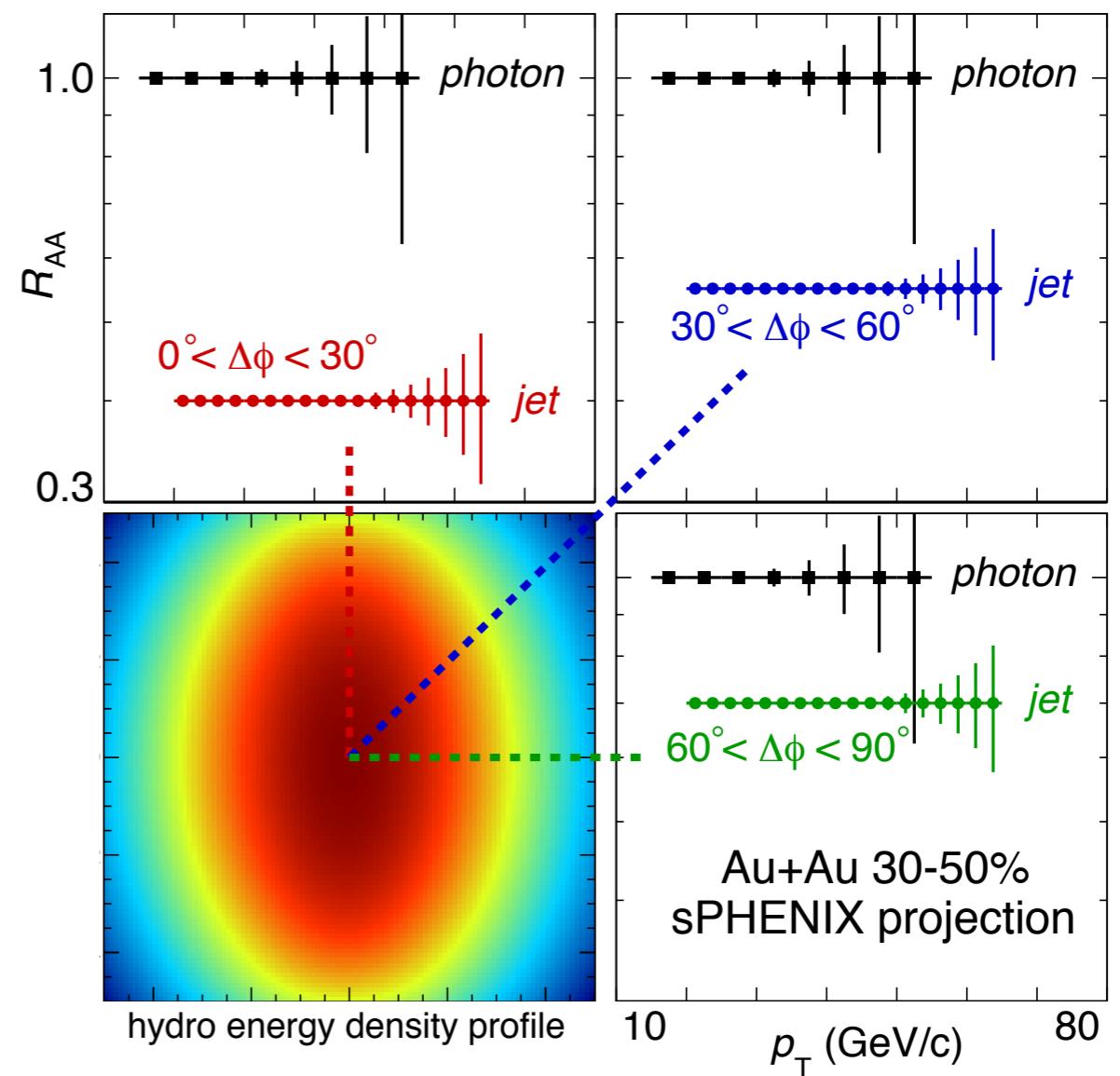


Non-Central Events I



Retains a significant interaction

Introduces a new physics interest

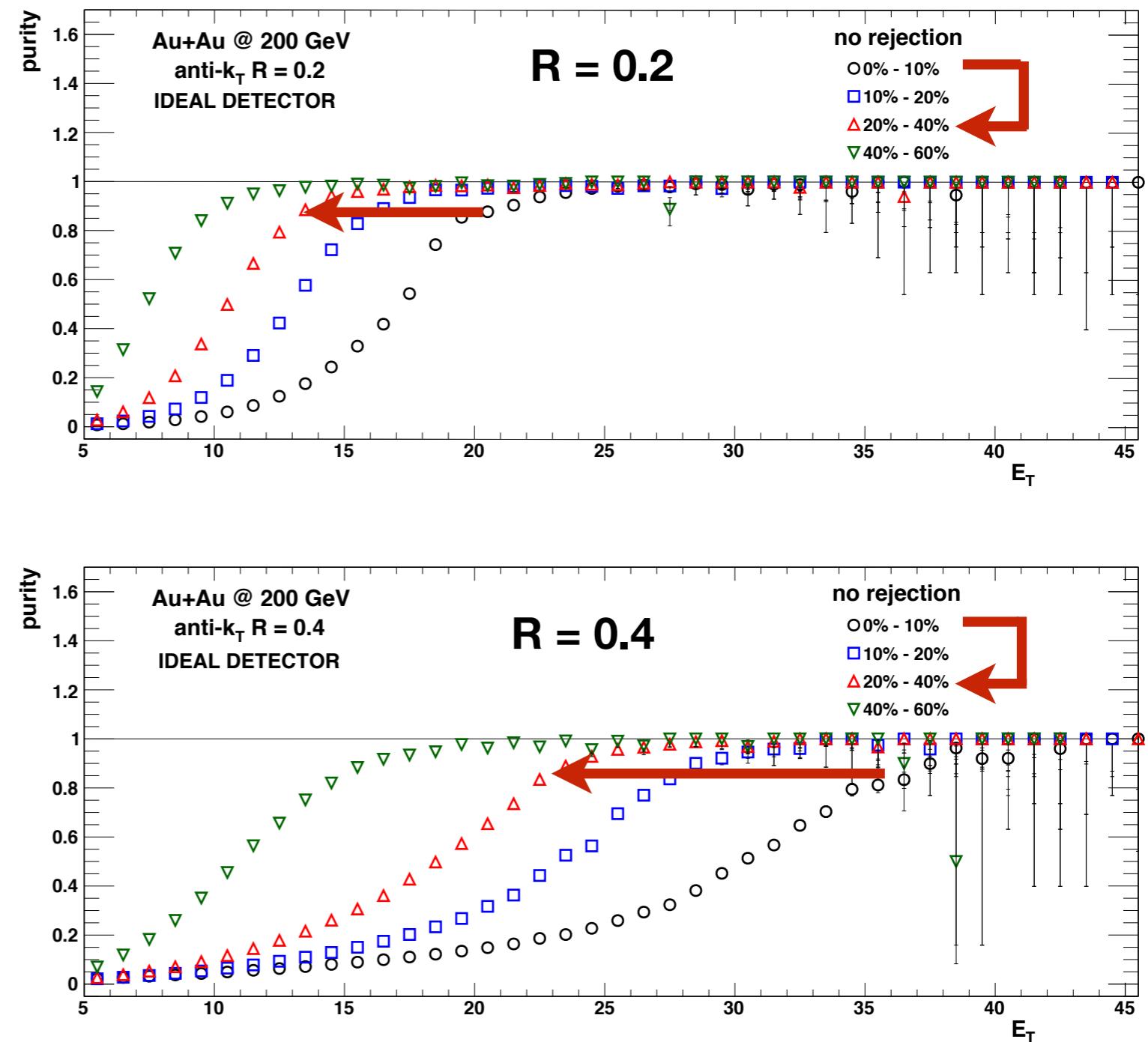
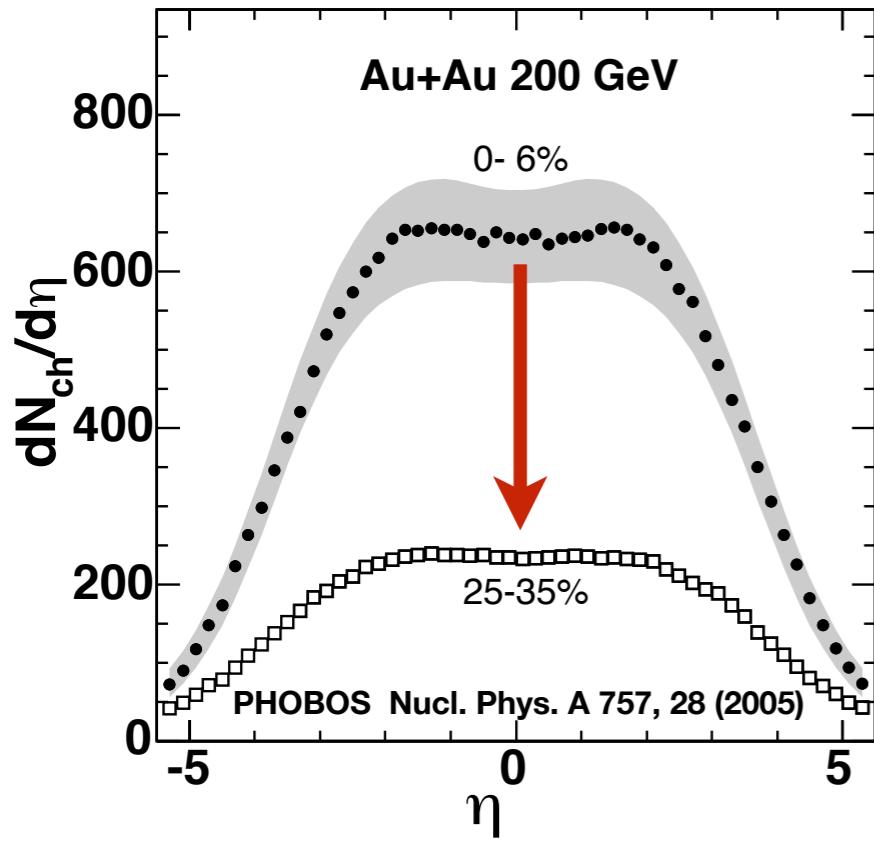


and observables

Non-Central Events II

Translates into Reduced Fake Jet Rate

Vast Reduction
of Event Multiplicity

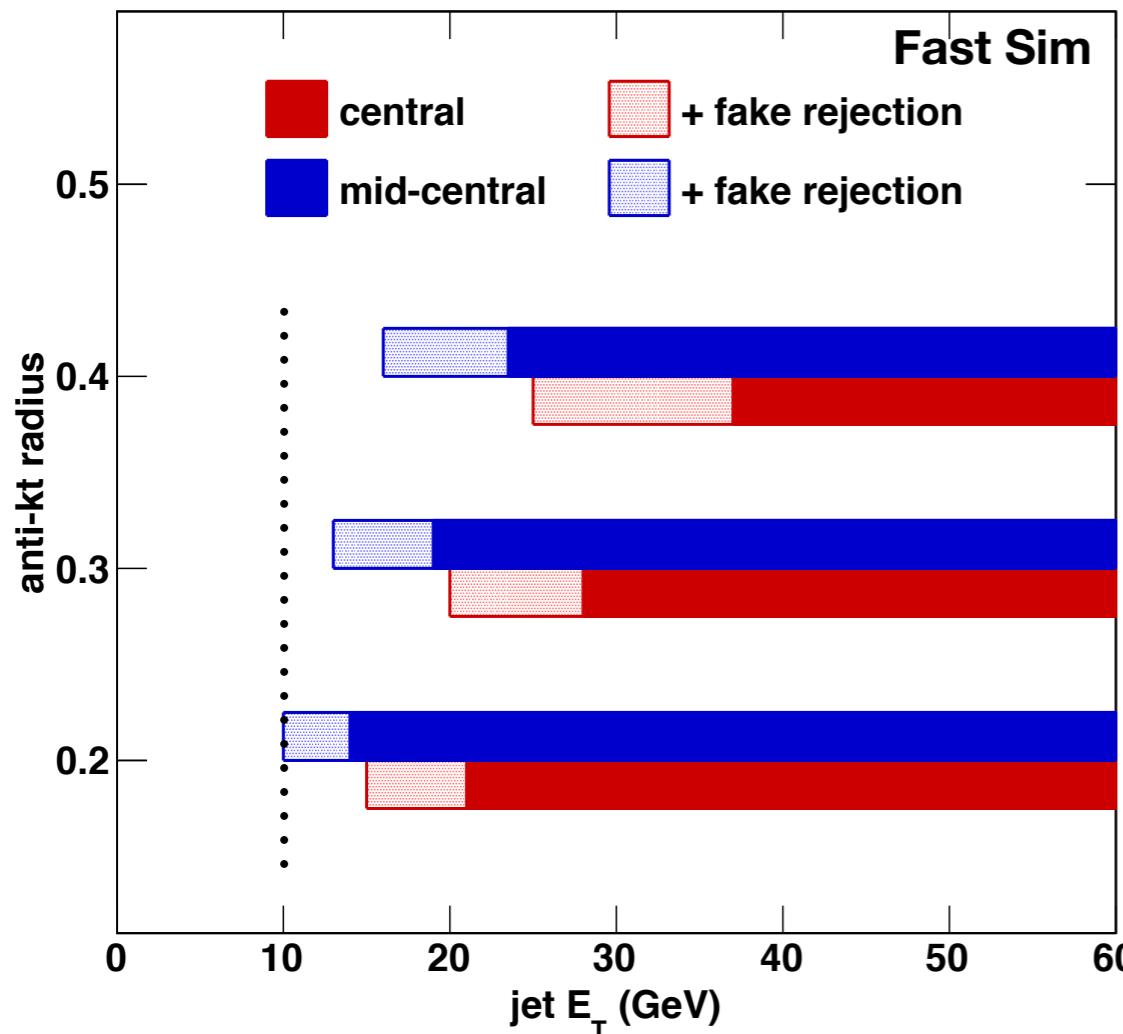


with additional physics coverage

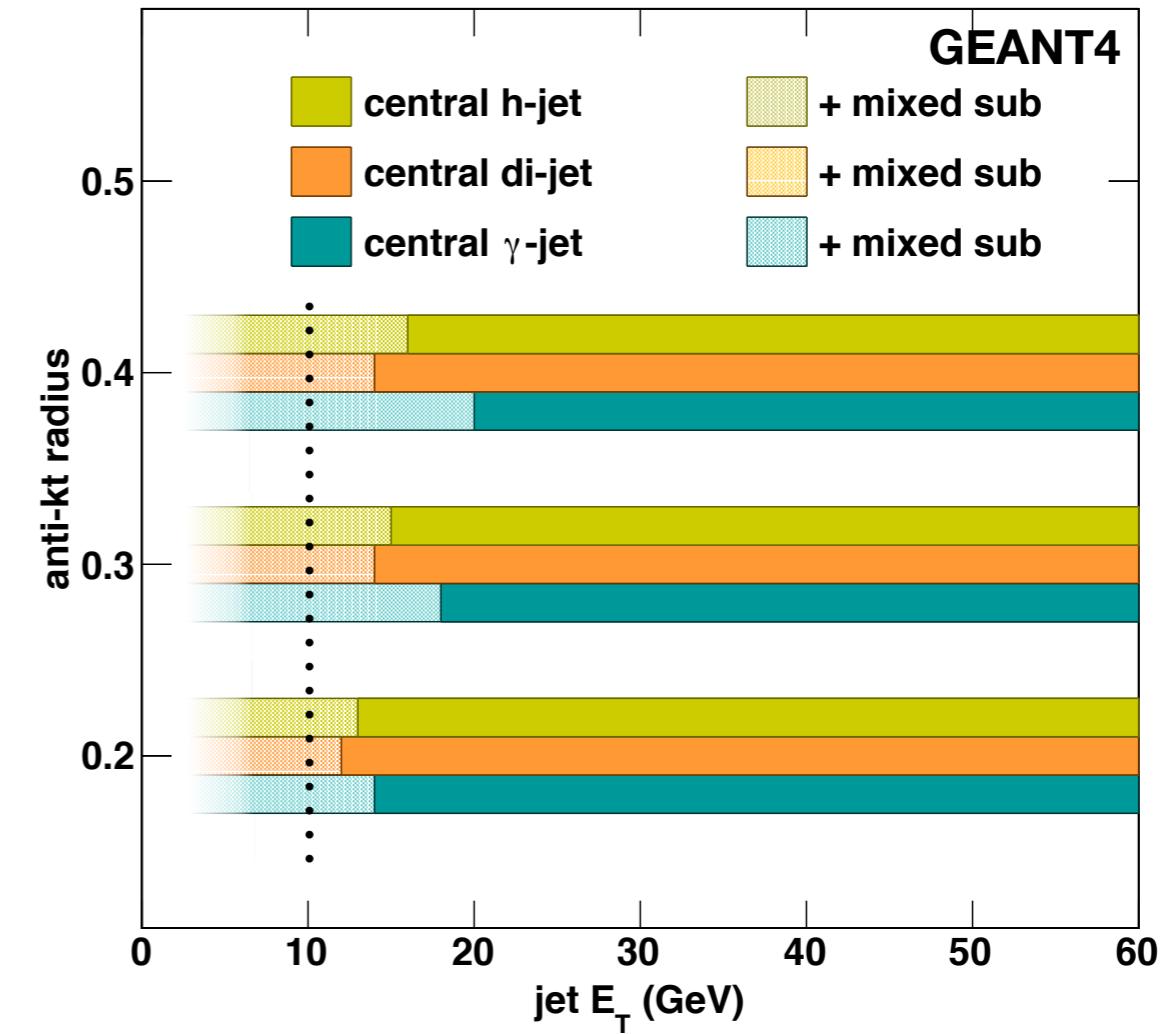
Kinematic Coverage Summary

>90% Purity Limit Summary

Single Jets



Conditional Away-side Jets

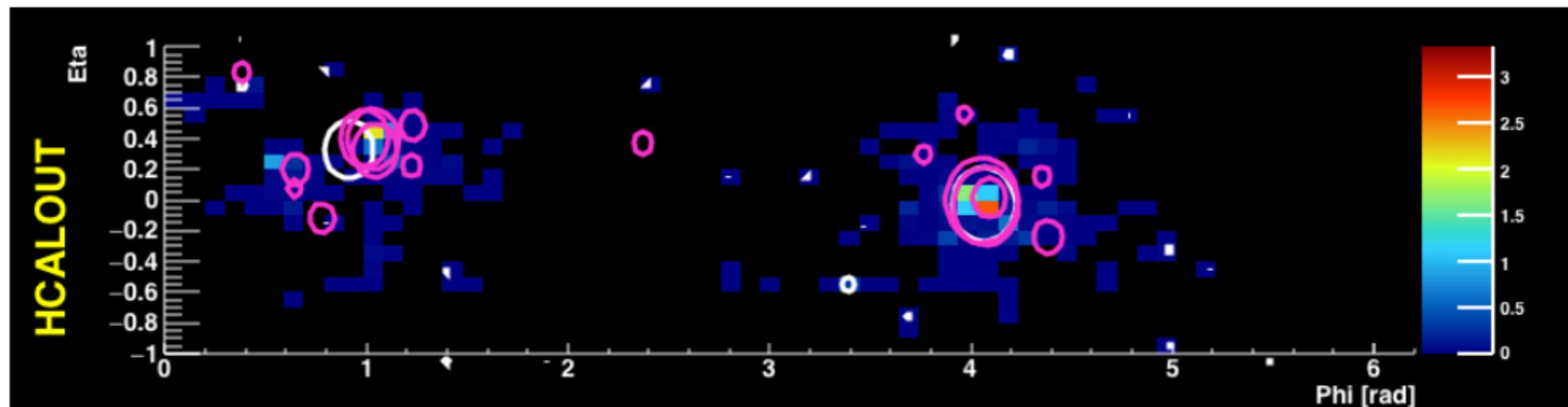
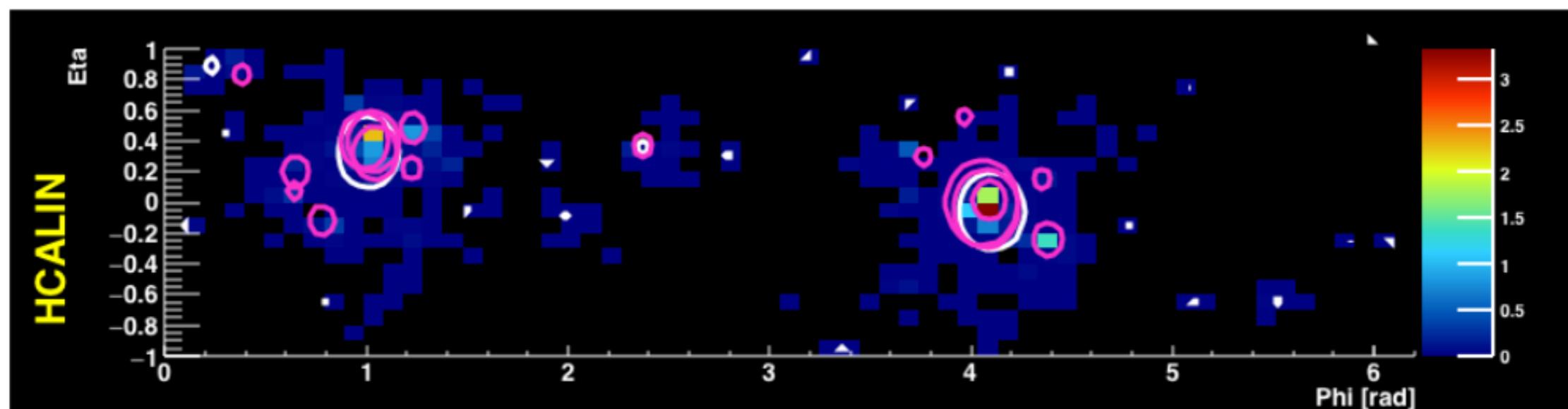
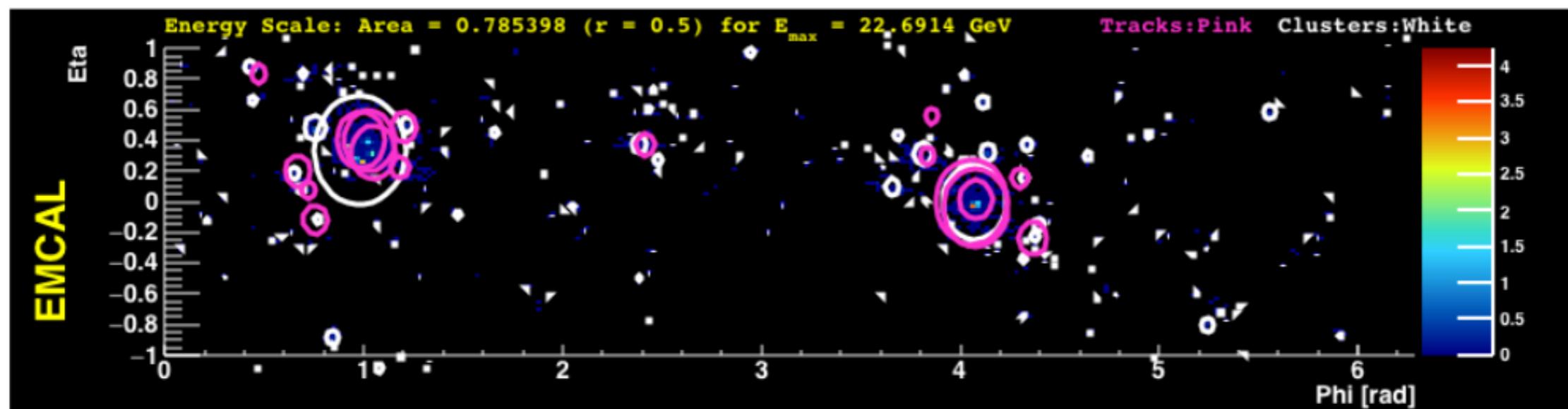


Comparative summary: Conservative 90% limits, mixed subtraction

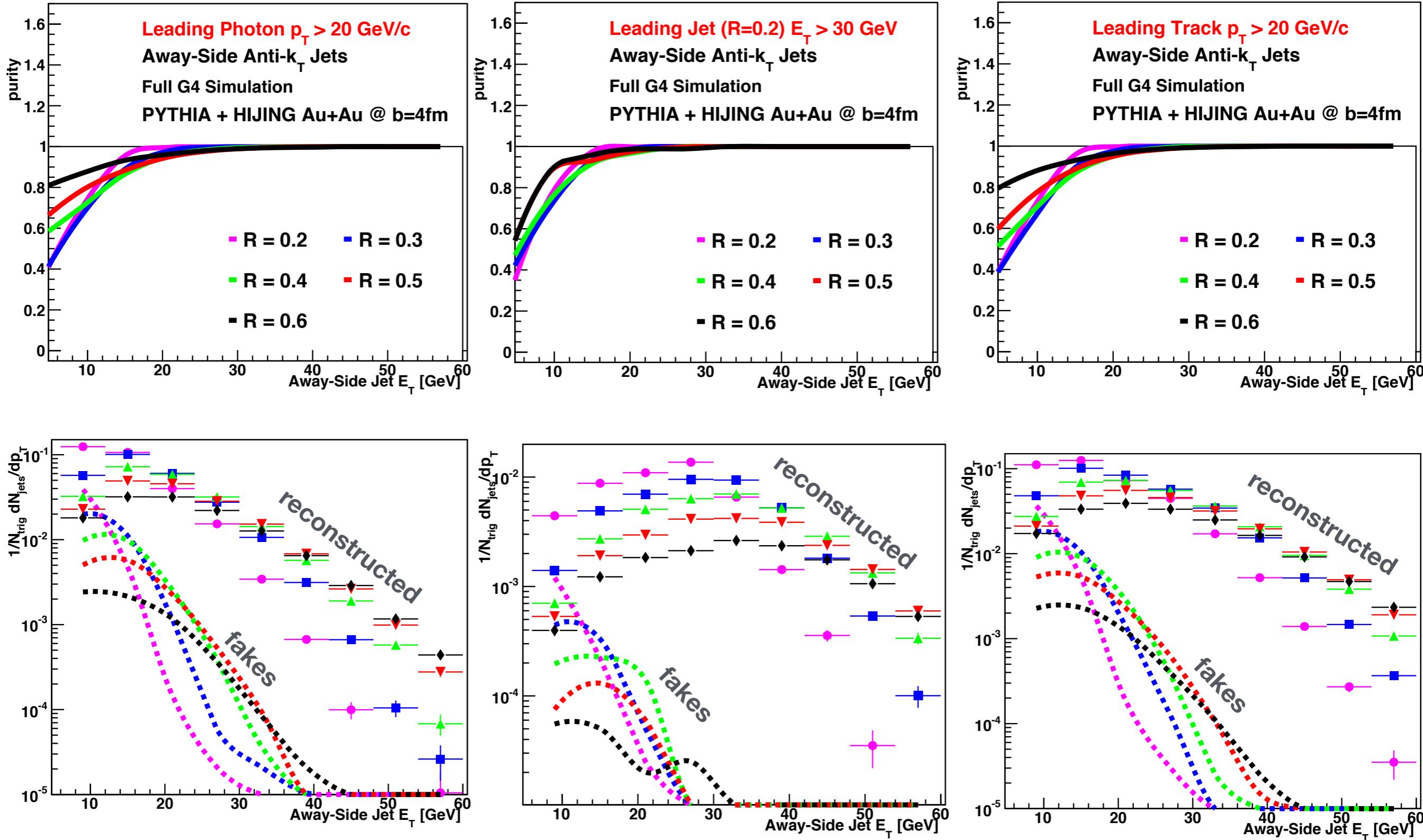
Switch to tracking to get to lowest energy scales

BACKUP SLIDES

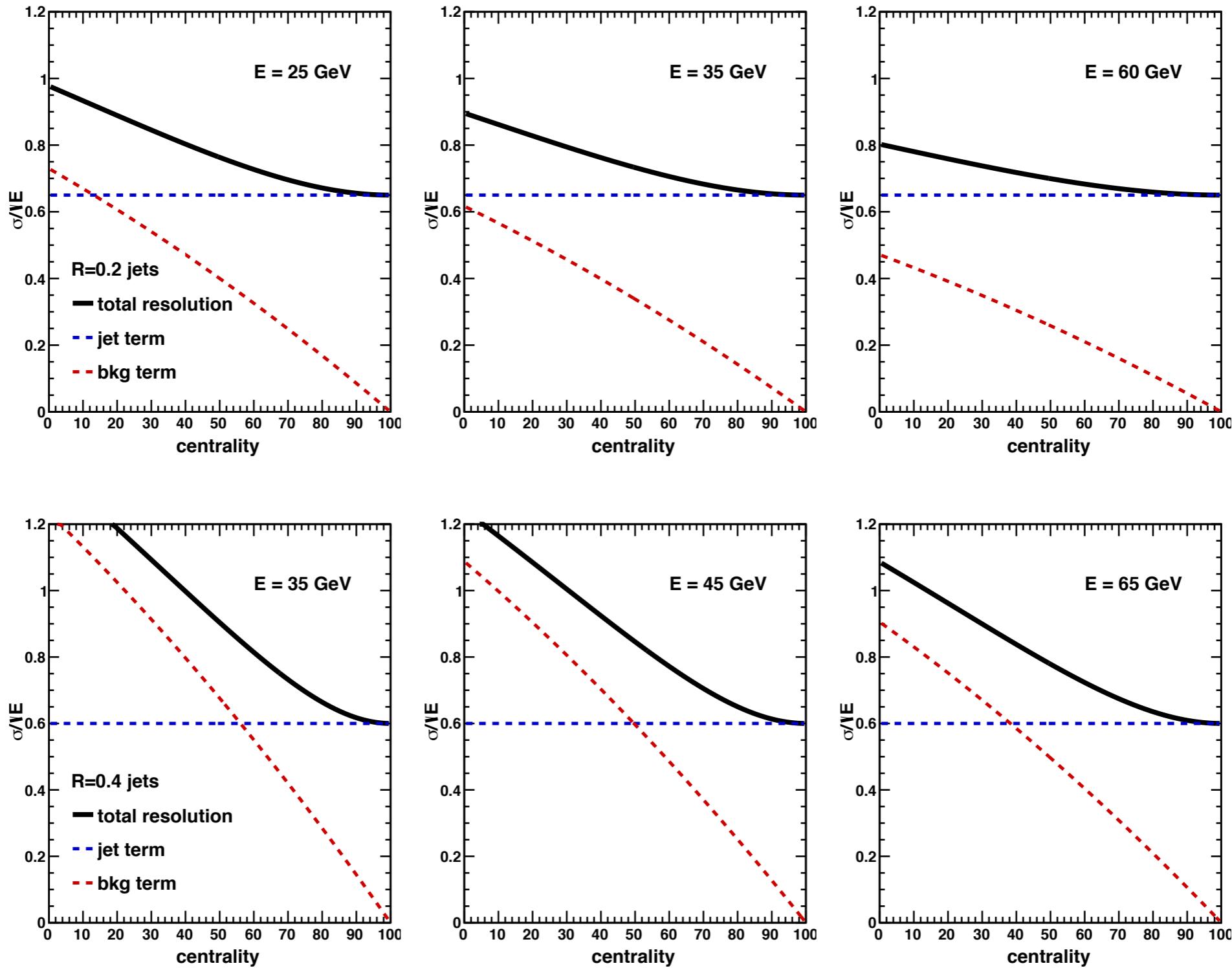
Particle-Flow Event Display



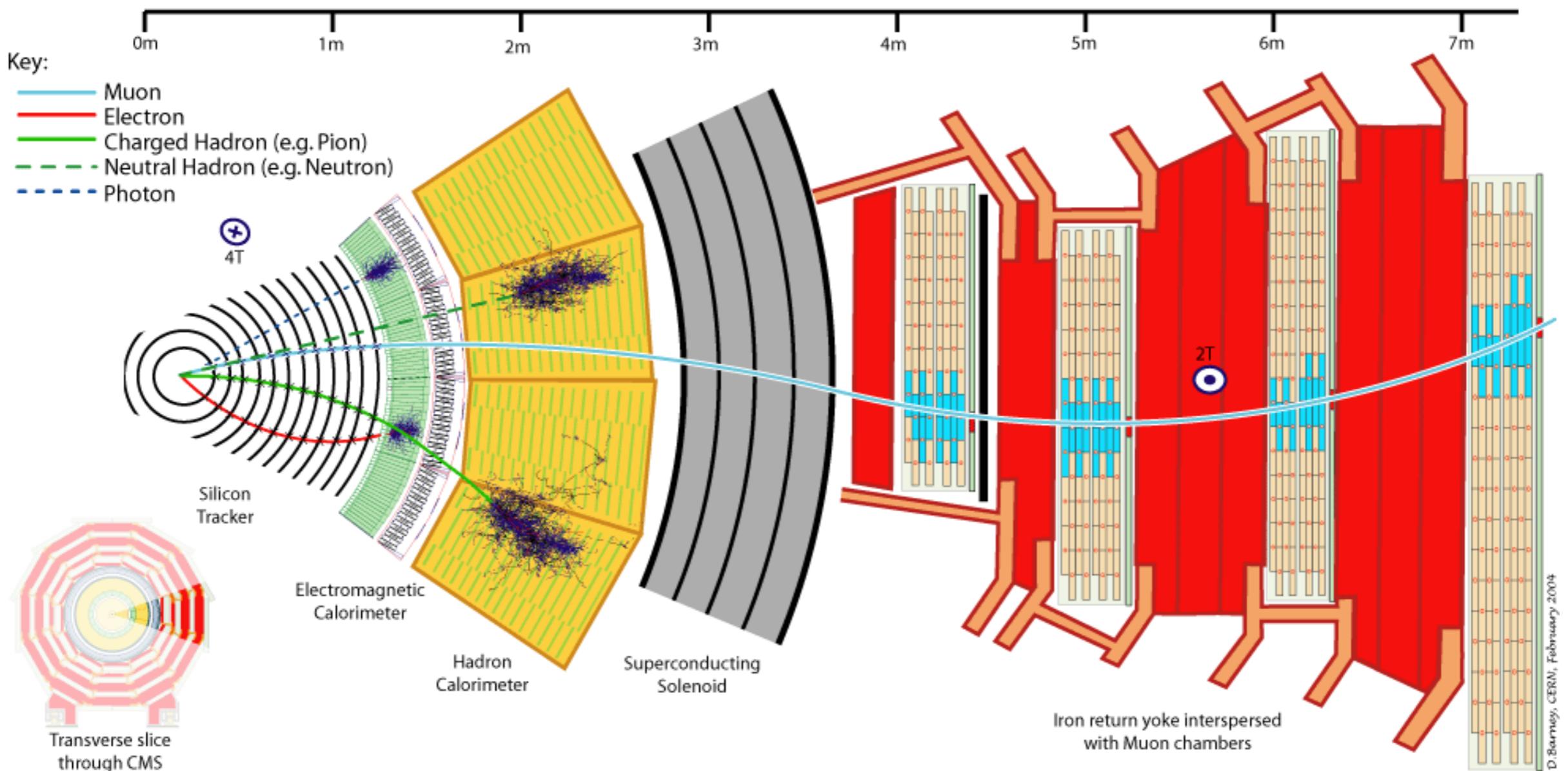
Conditional Spectra



Energy Resolutions with Backgrounds



Differences with CMS



sPHENIX has smaller field strength

sPHENIX calorimetry closer to beam

Bulk of sPHENIX hadronic calorimeter outside the magnet